

Al-Jazari: The Mechanical Genius

Tweet

Short link

by: Salim Al-Hassani The following short survey presents a rapid overview on the life, work and achievements of Al-Jazari, the most famous mechanical engineer of his time, some 1000 years ago. Al-Jazari brought Islamic technology to a culminant point. The author provides also web links and data related to the work achieved by himself and FSTC on Islamic technology, in general, and on Al-Jazari's ground breaking work, in particular.

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Al-Jazari was the most outstanding mechanical engineer of his time. His full name was Badi' al-Zaman Abu-'l-'Izz Ibn Isma'il Ibn al-Razzaz al-Jazari. He lived in Diyar-Bakir (in Turkey) during the 6th century H (late 12th century-early 13th century CE).



Figure 1: Wash-basin in the form of a peacock described by Al-Jazari in *Kitab fi Ma'rifat al-Hiyal al-Handisayya*. Manuscript copied in Sha'ban 6002/ March 1205. (Source).

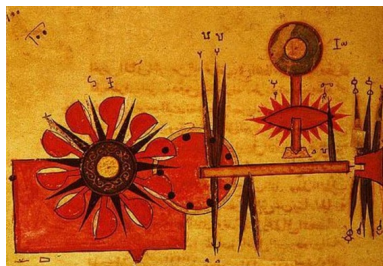
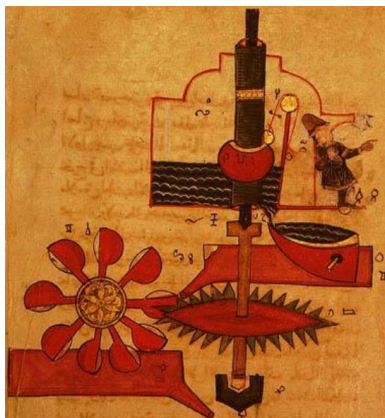


Figure 2 a-b

He was called Al-Jazari after the place of his birth, Al-Jazira, the area lying between the Tigris and the Euphrates in Mesopotamia. Like his father before him, he served the Artuqid kings of Diyar-Bakir for several decades (at least between 570 and 597 H/1174-1200 CE) as a mechanical engineer. In 1206, he completed an outstanding book on engineering entitled *Al-Jami' bayn al-'ilm wa-l-'amal al-nafi' fi sanat'at al-hiyal* in Arabic. It was a compendium of theoretical and practical mechanics. George Sarton writes: "*This treatise is the most elaborate of its kind and may be considered the climax of this line of Muslim achievement*" (Introduction to the History of Science, 1927, vol. 2, p. 510).



Figure 3: Model of a blood letting device as described by Al-Jazari and reconstructed in 1977. It measured the blood lost during phlebotomy (blood-letting) sessions, a popular therapy in the Islamic medieval world. Two scribes are seated above the device and their actions describe the amount of blood to be let. Currently on display in [The Science and Art of Medicine](#) (inventory number : 1981-1710). ([Source](#)).

Al-Jazari's book is distinctive in its practical aspect because the author was a competent engineer and skilled craftsman. The book describes various devices in minute detail, providing hence an invaluable contribution in the history of engineering. British charter engineer and historian of Islamic technology Donald R. Hill (1974) who held a special interest in Al-Jazari's achievements wrote:



Figure 4: Al-Jazari's water powered scribe clock brought back to life after 800 years by FSTC. The clock stands 1 metre high and half a metre wide; the scribe with his pen is synonymous to the hour hand of a modern clock. [Click here](#) to see the animation. ([Source](#)).

"It is impossible to over emphasize the importance of Al-Jazari's work in the history of engineering, it provides a wealth of instructions for design, manufacture and assembly of machines."



Figure 5: Picture of the internal structure of an automata for dispensating liquids. © JC Heuden at Virtual Worlds. ([Source](#)).

Al-Jazari described fifty mechanical devices in six different categories, including water clocks, hand washing device (*wudhu'* machine) and machines for raising water, etc. Following the "World of Islam Festival" held in the United Kingdom in 1976, a tribute was paid to Al-Jazari when the London Science Museum showed a successfully reconstructed working model of his famous "Water Clock."

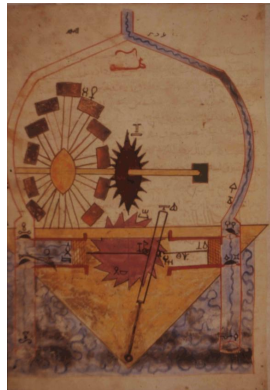


Figure 6: The original drawing of the double action or reciprocating pump from Al-Jazari's manuscript. Topkapi Palace Museum Library, Ahmet III, MS 3472. ([Source](#)).

Donald R. Hill translated into English Al-Jazari's book in 1974, seven centuries and 68 years after it was completed by its author. Al-Jazari's encyclopedic treatise includes six main categories of machines and devices. Several of the machines, mechanisms and techniques first appear in this treatise, later entering the vocabulary of European mechanical engineering. Among these innovations, we mention the double acting pumps with suction pipes, the use of a crank shaft in a machine, accurate calibration of orifices, lamination of timber to reduce warping, static balancing of wheels, use of paper models to establish a design, casting of metals in closed mould boxes with green sand, etc. Al-Jazari also describes methods of construction and assembly in scrupulous detail of the fifty machines to enable future craftsmen to reconstruct them.

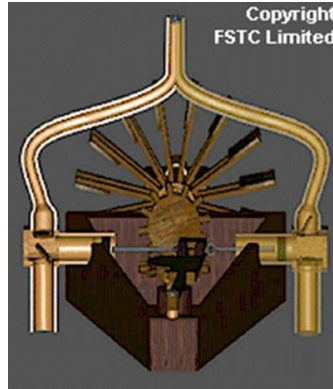


Figure 7: 3D model recreated by FSTC of the double action pump of Al-Jazari. [Click here](#) to view the animation. ©FSTC 2009.

And he was successful in that, for many of his devices were constructed following his instructions. The work by Al-Jazari is also unique in the way that other writers often fail to give sufficient details, because - amongst other factors - they were not craftsmen themselves, or kept their secrets, or if they were craftsmen, they could have been illiterate. Al-Jazari in this respect was unique, and this gives his work immense value. His book, Hill states, is an absolute wealth of Islamic mechanical engineering.

In their paper on "Mechanical Engineering during the Early Islamic Period" (published in *J. Mech. E, The Chartered Mechanical Engineer*, 1978, pp. 79-83), C. G. Ludlow and A. S. Bahrani have raised the important point that it is more than likely that there is more on the subject in some of the thousands of Arabic manuscripts in the world libraries which have not yet been inspected closely, and obviously require looking into.

Hill, too, constantly raises the two major issues with respect to the history of engineering in general, and that of fine technology in particular. He first states the fact that the field, which is absolutely immense, is yet largely unexplored.



Figure 8: View of The Elephant Clock: Leaf from a manuscript of Al-Jazari's *Kitab fi macrifat al-hiyal al-handasiyya* dated 715 H/1315 CE. ([Source](#)).

The other issue is related to fine technology. One of his concluding points states that "it is hoped that, as research proceeds, firmer evidence for the transmission of Islamic fine technology into Europe can be provided." Hill also offers some hints for such transmission. The most likely route was Spain. Such fine technology could have followed the same route as the astrolabe (itself part of this fine technology.) Apart from Spain, there were other possible lands of transfer: Sicily, Southern France, Italy, Byzantium and Syria during the Crusades. Hill is also right on a further account, that what will be seen in this work is just a fraction of the whole process, which, as with much else has hardly been explored.

The animation presented in figure 7 shows a virtual model of one of Al-Jazari's water raising pumps. The details of this unique pump were obtained from his manuscript and Hill's diagrams. We see two suction pumps in synchronous motion driven by a paddle wheel, which is driven by a water stream.



Figure 9: 3D model recreated by FSTC of the Elephant clock. [Click here](#) to view the animation. ©FSTC 2009.

The other animation is for a 3D model recreated from the description of the elephant clock as described by Al-Jazari (see below fig. 9). Full details of this animation are given in the works authored by the author and his collaborators published in the book *1001 Inventions: The Muslim Heritage in Our World* (chief editor Salim al-Hassani, Manchester: FSTC, 2006) and in articles that can be consulted online on www.MuslimHeritage.com (see especially the two special folders devoted to Islamic technology: [Al-Jazari](#) and [Taqi al-Din](#)).



Figure 10: A table device automaton designed by Al-Jazari. Manuscript dated from the early 14th century (1315), copied in Syria by Farrukh ibn Abd al-Latif. Opaque watercolor, ink and gold on paper. © The Smithsonian Institution, Washington. ([Source](#)).



Figure 11: A large ewer held by a kneeling female attendant in a domed pavilion designed by Al-Jazari: once the bird whistles, water pours into a basin below; a duck then drinks the used water and releases it through its tail into a container hidden under the platform. © The Smithsonian Institution, Washington. ([Source](#)).

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